Collect Oxygen Over Water

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TOOLS:

- Erlenmeyer flask (1)
- Glass (1)
  such as a small makeup mirror
- Lighter (1)
- Pneumatic trough (1)
- Stopper (1)
  #7 or to fit Erlenmeyer
- Tubing (2)
  5mm dia. x 80mm length
- Tubing (14")
  3/16" ID or to fit glass tubing
- Wire loop (1)

PARTS:

- Water (1)
  to fill trough
- Sulfur (<1g)
- Hydrogen peroxide (150 mL)
  from drugstore
- Magnesiumk dioxide (1/4 tsp)
  crude recovered from battery is fine
- Grease (1 mL)
  I used petroleum jelly, but technically I shouldn't have. Flammable greases should not be used with equipment containing pure oxygen gas, especially at elevated pressures and/or temperatures. To be completely safe, use silicone or other non-flammable grease.

SUMMARY

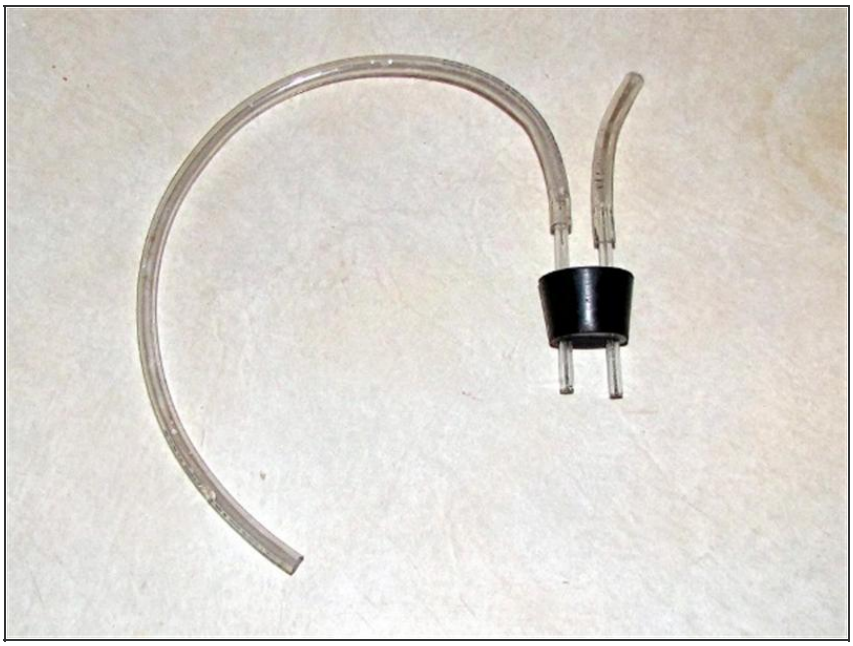
My previous tutorial shows how to construct a simple sheet metal "bridge," which, in

combination with an ice cube bucket and an olive jar, makes an effective pneumatic trough for collecting gas samples over water. This tutorial shows how to use this apparatus to generate and collect pure oxygen, and how to use that oxygen to observe the brilliant blue flame of sulfur oxidation. The manganese dioxide catalyst used in this process is easily recovered from a spent zinc-carbon battery.

Step 1 — Apply grease to jar rim

- Apply a bead of waterproof grease around the rim of the jar, which I will refer to henceforth as the "column."
- The grease will ensure a tight seal against the plate glass lid once the gas has been collected.
- Although I used petroleum jelly as a sealant, as a general rule, flammable greases like petroleum jelly should not be exposed to pure oxygen. There is no appreciable danger in this experiment, which involves only a small volume of oxygen at atmospheric pressure in a container with a free lid, but if you are working with larger volumes of oxygen, oxygen under higher pressure (as in a cylinder), or (most emphatically) liquid oxygen, do not use grease or other readily oxidizable materials in constructing apparatus.

Step 2 — Prepare stopper



- Insert a length of glass tubing into each of the openings in a two-hole rubber stopper. Applying a bit of grease to the outside of the tubing can make it easier.
- For safety's sake, grip the tubing through a towel if you have to push on it very hard.
- Cut two lengths of vinyl tubing, one about three inches long and one about 15 inches long.
- Fit the tubing sections over the protruding ends of the glass tubing sections, as shown.
- The short vinyl tube will serve as a valve which you can open or close as needed to control the flow of gas from the longer vinyl tube.

Step 3 — Fill column with water

- Fill the ice bin nearly to the rim with water.
- Submerge the column in the free end of the bin, angling it upward enough to fill it completely with water and release all air bubbles from within.
- Rotate the column underwater so that its open end is downward, then raise it until the open end is just barely submerged beneath the water's surface.
- Move the column over the bridge and screw the threads into place in the bridge's aperture. The column should be completely filled with water, with no air bubbles.

Step 4 — Start gas generator



- Review the MSDS for manganese dioxide here.
- Pour about 150mL of 3% hydrogen peroxide into the Erlenmeyer flask. Exact measurements are not important.
- Add about 1/4 tsp of manganese dioxide (about half the amount shown in the photo is plenty). The reaction will begin immediately, and will generate some heat.
- Although the exact measurements are not important, if you overdo the manganese dioxide the reaction can go too fast and possibly boil over.
- Insert the two-hole stopper, prepared as above, into the neck of the Erlenmeyer flask. Get a good seal, but don't push it down too hard.

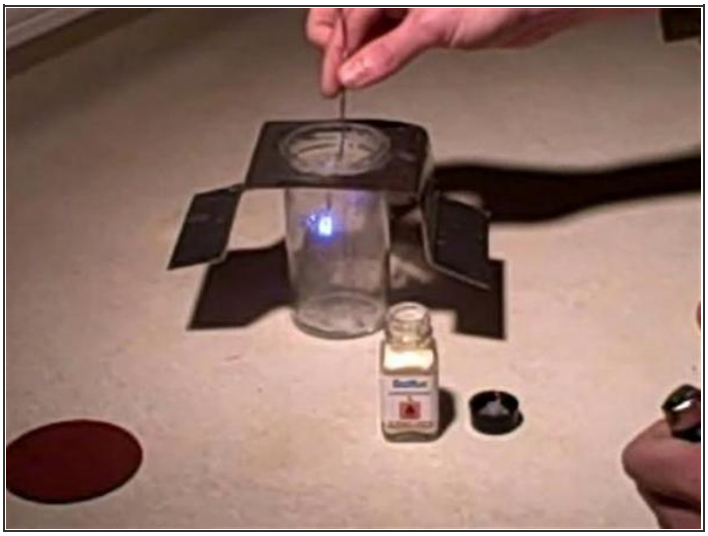
Step 5 — Fill column with gas

- Let the reaction run for a couple of seconds to clear residual atmospheric gases from the headspace in the flask and from the tubing.
- Pinch off the short length of tubing by folding it over between your fingers.
- Direct the open end of the longer length of tubing into the water below the column, so that the bubbles rise into the volume of the column itself, displacing the water therein.
- Continue until the bubbles spill out around the bottom of the column. Release the short end of the tubing and set the flask aside, allowing the reaction to go to completion. Excess oxygen may be safely released into the atmosphere; other gases will require ventilation.

Step 6 — Seal and remove column

- Insert the plate glass cover into the water bath and position it against the submerged rim of the glass. The bead of grease on the rim of the jar should seal against the surface of the glass.
- Lift the glass, bridge, and column out of the water together, tilt them to drain off any puddles, and then invert them and set them upright on the bench. If you used the gas-generating reaction described here, you now have a jar of pure oxygen.

Step 7 — Confirm elevated oxygen (optional)



- If you have generated oxygen, you can confirm--if not pure oxygen gas--then at least a dramatically oxygen-enriched atmosphere by observing the combustion of elemental sulfur.
- Be sure that your workspace is well-ventilated, as the sulfur dioxide generated in the process is fairly acrid. An MSDS for sulfur dioxide can be found here.
- Load a pinch of powdered sulfur onto your wire loop. Moistening the loop can help if you have problems recovering a good amount from the bottle.
- Heat the sulfur sample in the flame of a butane lighter. The sulfur will turn black and smolder but may not actually ignite.
- Quickly remove the plate glass cover on the gas column and insert the smoldering end of the wire loop. If you've done everything right, you will be treated to a beautiful blue flare.

The oxygen generating-reaction is as follows:

$2H_2O_2 \rightarrow 2H_2O + O_2(g)$

The only products are water and oxygen. Manganese dioxide is present as a catalyst, meaning it is neither consumed nor created during the course of the reaction, and is added only to accelerate the decomposition of hydrogen peroxide. That means it can be preserved and reused indefinitely. To recover it, pour the contents of the Erlenmeyer flask, and any washings that contain the black manganese dioxide powder, into an evaporating dish or shallow, wide-mouth jar. Then just set it aside in a window and/or in front of a fan and let the water evaporate away.

The dry manganese dioxide that remains can be reused more-or-less indefinitely. If you're impatient, you can filter the manganese dioxide out of the water using a coffee filter to speed the whole process up.

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